FY04 Technical Program Summary

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Vehicle Technology Directorate -
Glenn Site
US Army Research Laboratory
at
NASA Glenn Research Center
Cleveland, OH 44135-3191

The ARL Vehicle Technology Directorate at the Glenn Research Center conducts research in two business areas:

Engine Technologies and
Power Transmission

Program areas funded under these technical competencies include basic (6.1) and applied (6.2) research in Aviation Technology and Ground Vehicle Technology. The following "Table of Contents" outlines the organization of the work packages and individual research projects within this document.

Aerodynamic Components Research - 6.1 - 61102 / AF20 / VP1A11F

VP1A11F.0161-01	Compressors - Ultra Efficient Engine Technology (UEET)
VP1A11F.0161-02	Centrifugal Compressor Flow Physics
VP1A11F.0161-03	Wave Rotor Development
VP1A11F.0161-04	Flow Control Technology
VP1A11F.0161-14	Structures - Fatigue of Metallic Materials
VP1A11F.0161-15	Materials - Improved PMR Solution and PMR Prepreg Stability
VP1A11F.0161-16	Materials - Silicon Based CMC for Turbine Components
VP1A11F.0161-17	Materials - Numerical Modeling of Oxidation Kinetics of CMCs
VP1A11F.0161-19	Controls - Autonomous Robotic Controls Technology
VP1A11F.0161-20	Materials - Advanced 3000F Coating Concept
VP1A11F.0161-21	Controls - Autonomous Propulsion System
VP1A11F.0161-22	Controls - Model Based Controls and Diagnostics
VP1A11F.0161-23	Materials - Improved Oxidation Resistance of CMCs
VP1A11F.0161-24	Ultrahigh Temperature Ceramic Matrix Composites

Mechanical Components Research - 6.1 - 61102 / AF20 / VP1A13F

VP1A13F.0161-09	Mechanical Components - Damage Assessment
VP1A13F.0161-10	Mechanical Components - Gear Tooth Crack Propagation Studies

Internal Combustion Engine Research - 6.1 - 61102 / AF20 / VP1T14F

VP1T14F.0161-12	Mechanical Components - Advanced Journal Bearing Analyses
VP1T14F.0161-13	Mechanical Components - Oil-Free Foil Bearing Technology

R/C Drive Systems/21st Century (RDS21) - 6.2 - 62211 / A47B / VP2A15D

VP2A15D.0162-08	Rotorcraft Drives - High Power Density Drive Systems
VP2A15D.0162-09	Rotorcraft Drives - Face Gear Development
VP2A15D.0162-10	Rotorcraft Drives - High Speed Helical Gear Thermal Behavior

STO - Small Heavy Fuel Engine - 6.2 - 62211 / A47B / VP2A20G

VP2A20G.0162-01	Advanced Centrifugal Compressor
VP2A20G.0162-02	Computational Grid Environment for 3D Propulsion Simulations
VP2A20G.0162-03	Turbines - Ceramic Matrix Composite Component - Rig Demonstration
VP2A20G.0162-04	Turbines - Monolithic Ceramic and Ceramic Matrix Composite (CMC) Turbine Nozzle
VP2A20G.0162-05	Mechanical Components - Seals Research
VP2A20G.0162-06	Mechanical Components - Magnetic Bearing Technology
VP2A20G.0162-07	Mechanical Components - Oil-Free Turbomachinery
VP2A20G.0162-11	Active Stall Control Development
VP2A20G.0162-12	Materials - Low Conductivity Thermal Barrier Coating Development
VP2A20G.0162-13	Actively Cooled Ceramic Matrix Composite Panel

Date Last Modified: 16-JAN-04

BUSINESS SUBAREA:	6.2		Applied Research	
PE/PRJ/WP#/WP:	62211	A47B	VP2A20G	STO - Small Heavy Fuel Engine
DIRECTORATE/DIVISION	Vehicle Technology		Engine Components Division (ECD)	
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THRUST:

Advance the technology readiness level of specific engine component technologies and high temperature material systems to enable demonstration of large increases in system power-to-weight ratio while maintaining or increasing life and realibility metrics.

OBJECTIVES:

Provide engine component level technology and high temperature materials and structures concepts to enable a small, lightweight, efficient heavy fuel propulsion capability supporting A160 and other class 4 UAVs.

PROGRAM SCHEDULE:

RESEARCH STUDIES	2003	2004	2005	2006	2007
Advanced Centrifugal Compressor	▪▪▪▪	▪▪▪▪			
Computational Grid Environment for 3D Propulsion Simu	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Turbines - Ceramic Matrix Composite Component - Rig D	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Turbines - Monolithic Ceramic and Ceramic Matrix Com	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Mechanical Components - Seals Research	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Mechanical Components - Magnetic Bearing Technology	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Mechanical Components - Oil-Free Turbomachinery	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Active Stall Control Development	▪▪▪▪	▪▪▪▪	▪▪▪▪		
Materials - Low Conductivity Thermal Barrier Coating De	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Actively Cooled Ceramic Matrix Composite Panel	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

FY04 KEY DELIVERABLES:

- Develop low conductivity, high toughness, erosion resistant tetragonal and cubic phase structured ZrO2 based thermal barrier coatings using novel nano-structured, tetragonal/cubic six component systems.
- Optimize and scale up the processing of low conductivity ceramic coating systems.
- Complete fabrication of HPBR test section of first stage turbine vane.
- Complete design of first stage turbine for HPBR testing
- Transition range enhancement technology to T700 engine demonstration.
- Create a plan to develop a GRID interface for accessing HDF and flat files on the IPG by using an Open Grid Service Infrastructure (OGSI) based services.
- Create a research plan for developing a GRID model for accessing cluster based distributed Supercomputers.
- Develop methods of avoiding surface reaction on gel cast silicon nitride parts
- Determine impact damage mechanisms in EBC and TBC coated silicon nitride bend bars

This chart covers Fiscal Year 2004

Business SUBAREA:	6.2		Applied Research	
PE/PRJ/WP#/WP:	62211	A47B	VP2A20G	STO - Small Heavy Fuel Engine

Workyears	2003	2004	2005	2006	2007
ARMY	10	11	11	8.5	8.5
NASA	10.2	10.9	11	10.7	10.7
OTHER	3.9	4.9	4.9	1.3	1.3

Applied Research

OBJECTIVE

Provide engine component level technology and high temperature materials and structures concepts to enable a small, lightweight, efficient heavy fuel propulsion capability supporting A160 and other class 4 UAVs.

APPROACH

The deliverables are demonstrations/validations of new ideas, techniques, tools, and concepts, which will lead to improved gas turbine aerodynamic components (compressors, combustors, turbines) and mechanical components (bearings, seals, shafts) with reduced technical risk, time, and cost during the development cycle. Included are technologies to address dynamics and operability of the engine/compression system. Stability enhancement for high performance turbomachinery is included, having as a goal operation nearer the compressor surge line while maintaining engine stability. Also included is the development of CMC turbine components (nozzle) for uncooled operation at temperature up to 2700 degrees F, and approaches that will enable the introduction of cooling into CMC structures without compromising structural durability of manufacturability. High-temperature magnetic bearings will withstand future operating temperatures and, in conjunction with shaft dynamics modeling, will overcome stability limitations of flexible engine shafts operating in very hot environments, which exhibit large numbers of modes. Oil-free turbomachinery will enable engines with reduced maintenance, greater fuel-efficiency, lighter weight, more reliability and durability, enhanced survivability, improved deployability, and an overall smaller logistics footprint. High temperature advanced seal concepts will allow precise control in engine secondary airflow systems applications. All of these developments are driven by the increasingly difficult requirements to develop advanced propulsion systems within decreased time and cost constraints. Target goals for the Small Heavy Fuel Engine include a 20% reduction in specific fuel consumption, a 50% increase in horsepower-to-weight ratio, and a 35% reduction in operation and support cost. The generated information is disseminated to U.S. gas turbine engine manufacturers via technical reports and seminars. These demonstrations give the manufacturers the confidence to incorporate the new ideas, techniques, tools, and concepts into their product lines at the earliest possible date, resulting in improved products being sought by the end user. The described efforts are being performed as joint technical programs between the Army VTD- Glenn Site and the NASA Glenn Research Center. The VTC- Glenn Site thus leverages NASA dollars, manpower, and test facilities. Support for the SHFE STO begins in FY04 and continues through 2007.

SIGNIFICANCE

This workpackage supports the developement of advanced rotorcraft and ground vehicles with improved range/payload and performance attributes. The logistics support burden is reduced through reductions in fuel requirements. The derived technologies are applicable to future systems or fielded/developmental system upgrades

PROGRAM SCHEDULE:

RESEARCH STUDIES					
Advanced Centrifugal Compressor	▪▪▪▪	▪▪▪▪			
Computational Grid Environment for 3D Propulsion Simu	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Turbines - Ceramic Matrix Composite Component - Rig D	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Turbines - Monolithic Ceramic and Ceramic Matrix Com	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Mechanical Components - Seals Research	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Mechanical Components - Magnetic Bearing Technology	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Mechanical Components - Oil-Free Turbomachinery	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Active Stall Control Development	▪▪▪▪	▪▪▪▪	▪▪▪▪		
Materials - Low Conductivity Thermal Barrier Coating De	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪
Actively Cooled Ceramic Matrix Composite Panel	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪	▪▪▪▪

- (06/04) Complete 1200F performance test for HFPNCS design.(09/04) Validate/calibrate analysis and design tool for HFPNCS.
- (09/04) Complete heater upgrade for 1500F operation.
- Test 1000 F magnetic thrust bearing.
- Perform 1000 F magnetic bearing endurance test contingent on funding.
- Complete unsteady full-annulus simulations of transonic axial & centrifgual compressors both with and without stall control model.
- Complete design & fabrication of engine modifications for implementing stall control technology. Initiate engine testing of stall control technology.
- Perform gas stand tests on an Oil-Free turbocharger under simulated operating conditions
- Design of a Stryker/FMTV sized Oil-Free turbocharger for in-service demontration

This chart covers Fiscal Year 2004